Ecole Polytechnique Fédérale de Lausanne

# Course syllabus – extracts

- Name – First name of the student: GENIN Aurélien

- Academic years completed: M1 (H2 2024), M2 (H1 2025)
- Current academic year: M3 (H2 2025)
- Major: Robotics
- Minor: Space science technologies

- Full course catalogue available here: https://search.epfl.ch/?q=

**Legend:**

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| MICRO/CIVIL/ENV | Robotics |
| ME/EE | Applied mathematics |
| EE/ENG | Space technologies |
| PHYS | Physics |
| HUM | Humanities and Social Sciences |

**M1:**

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| **MICRO-452**<br>**Basics of mobile robotics**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Mondada Francesco** | The course teaches the basics of autonomous mobile robots. Both hardware (energy, locomotion, sensors) and software (signal processing, control, localization, trajectory planning, high-level control) will be tackled. The students will apply the knowledge to program and control a real mobile robot. |
| **MICRO-507**<br>**Legged robots**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Ijspeert Auke** | The course presents the design, control, and applications of legged robots. It gives a review of different types of legged robots (including two-, four- and multi-legged robots), and an analysis of different control methods for legged locomotion. It also trains students in making critical analysis of key articles in the field, and in designing their own models and locomotion controllers for legged robots in simulation. |
| **EE-584**<br>**Spacecraft design and system engineering**<br>**(5 ECTS)**<br><br>**Professors:**<br>**David Emmanuelle Brigitte Marie, Udriot Mathieu Jean-Pierre** | The main objective of the course is to provide tools and notions for spacecraft design. The course will start with an introduction on systems engineering, then the different subsystems of a spacecraft will be explored. External teachers from industry will bring their expertise. |
| **MICRO-450**<br>**Basics of robotics for manipulation**<br>**(3 ECTS)**<br><br>**Professor:**<br>**Bouri Mohamed** | This course introduces the basics of robotics for manipulation. The aspects concerning robot architectures (Serial, Parallel and Cartesian), sensors, kinematics and dynamic modelling and control are presented. Each of these theoretical topics is in concern with a industrial context. |

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| **EE-585**<br>**Space mission design and operations**<br>**(2 ECTS)**<br><br>**Professor:**<br>**Kuntzer Thibault Adrien** | This course is a "concepts" course. It introduces a variety of concepts to design and operate a space mission. These concepts cover orbital mechanics, spacecraft operation phases and critical subsystems. |
| **EE-589**<br>**Project in space technology**<br>**(12 ECTS)**<br><br>**Supervisor:**<br>**Kneib Jean-Paul Richar** | The aim of this course is to give students the practical skills to carry out a project linked to the development of space technologies. The subject of the project is defined after discussion with the teaching staff. The projects will always be part of the Swiss Space Center's projects.<br><br>Performed at the EPFL Spacecraft Team on the "Programming and optimization of algorithms to enable autonomous tracking of satellites with an X-band antenna" |
| **ME-425**<br>**Model Predictive Control**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Jones Colin Neil** | Provide an introduction to the theory and practice of Model Predictive Control (MPC). Main benefits of MPC: flexible specification of time-domain objectives, performance optimization of highly complex multivariable systems and ability to explicitly enforce constraints on system behavior. |
| **HUM-490**<br>**Scientific mediation I**<br>**(3 ECTS)**<br><br>**Professors:**<br>**Albertini Marion, Dutto Fabrizia, Pontais Anna Elisabeth** | Students will learn how to convey scientific content to different types of audience and using different mediation formats. This year, the course will culminate in the creation and running of an interactive educational workshop with a group of young people.<br>During the first semester, specialists in the fields concerned will cover the theoretical foundations for understanding the issues and methods involved in scientific outreach: communication, sociology of science-society relations, psychology of learning and educational design.<br>In parallel with these theoretical contributions, students will draw up a mediation project: they will identify a scientific theme, adapt the content of their discourse to the target audience and draw up a detailed plan for implementing their mediation activity.<br>The second semester will be devoted to implementing the project developed in the first semester. Students will work on prototyping their mediation activity within the allocated budget, and on creating and formalising the visual and textual content. They will have to present their activity to a group of young people and suggest ways of improving their project.<br>During the course, students will be coached through all phases of the project, from design to presentation. |

## M2:

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| **ENG-411**<br>**Concurrent engineering of space missions**<br>**(2 ECTS)**<br><br>**Professors:**<br>**Udriot Mathieu Jean-Pierre, Verkammen Marnix Hendrik G** | The main objective of this course is to teach the students the fundamentals of concurrent engineering for space missions and systems. The course is built around a similar framework to that of the European Space Agency's (ESA) Concurrent Engineering Challenge. |
| **MICRO-502**<br>**Aerial robotics**<br>**(5 ECTS)**<br><br>**Professor:** | The course provides an introduction to the design, control, and applications of aerial robots. Students will be able to translate theoretical concepts into practice by means of hands-on exercises with simulated and real drones. |

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| **Floreano Dario** | |
| **MICRO-372**<br>**Advanced mechanisms for extreme environments**<br>**(3 ECTS)**<br><br>**Professor:**<br>**Cosandier Florent** | This course presents advanced mechanical engineering concepts through concrete examples of precision mechanisms. These mechanisms operate in extreme environments, whether in space or on earth. Theoretical concepts are covered in depth, as well as environmental constraints. |
| **EE-580**<br>**Introduction to the design of space mechanisms**<br>**(2 ECTS)**<br><br>**Professor:**<br>**Feusier Gilles** | Space environment is different from what we can experience on Earth, requiring specific design approaches in order to achieve reliable operations. Engineers must hence face new challenges stimulating their creativity to tackle those particular constraints. |
| **EE-559**<br>**Deep Learning**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Cavallaro Andrea** | This course explores how to design reliable discriminative and generative neural networks, the ethics of data acquisition and model deployment, as well as modern multi-modal models. |
| **CIVIL-459**<br>**Deep learning for autonomous vehicles**<br>**(6 ECTS)**<br><br>**Professor:**<br>**Alahi Alexandre Massoud** | Deep Learning (DL) is the subset of Machine learning reshaping the future of transportation and mobility. In this class, we will show how DL can be used to teach autonomous vehicles to detect objects, make predictions, and make decisions. (Fun fact: this summary is powered by DL) |
| **PHYS-402**<br>**Astrophysics V : observational cosmology**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Kneib Jean-Paul Richard** | Cosmology is the study of the structure and evolution of the universe as a whole. This course describes the principal themes of cosmology, as seen from the point of view of observations. |
| **MICRO-453**<br>**Robotics practicals**<br>**(4 ECTS)**<br><br>**Professors:**<br>**Billard Aude, Boero Giovanni, Bouri Mohamed, Floreano Dario, Kneib Jean-Paul Richard, Micera Silvestro, Mondada Francesco, Sakar Mahmut Selman, Skaloud Jan** | The goal of this lab series is to practice the various theoretical frameworks acquired in the courses on a variety of robots, ranging from industrial robots to autonomous mobile robots, to robotic devices, all the way to interactive robots. |
| **ENV-548**<br>**Sensor orientation**<br>**(4 ECTS)**<br><br>**Professor:**<br>**Skaloud Jan** | Determination of spatial orientation (i.e. position, velocity, attitude) via integration of inertial sensors with satellite positioning. Prerequisite for many applications related to remote sensing, environmental monitoring, mobile mapping, robotics, space exploration, smart-phone navigation, etc. |

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| **HUM-492**<br>**Scientific mediation II**<br>**(3 ECTS)**<br><br>**Professors:**<br>**Albertini Marion, Dutto Fabrizia, Pontais Anna Elisabeth** | Follow-up course to HUM-490 |

## M3:

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| **ENV-540**<br>**Image processing for Earth observation**<br>**(4 ECTS)**<br><br>**Professor: Tuia Devis** | This course covers optical remote sensing from satellites and airborne platforms. The different systems are presented. The students will acquire skills in image processing and machine/deep learning to extract end-products from the images such as land cover or risk maps. |
| **PHYS-465**<br>**Astrophysics III : galaxy formation and evolution**<br>**(4 ECTS)**<br><br>**Professor: Hirschmann Michaela** | Galaxy formation & evolution is about studying how galaxies in our Universe come into existence, how they evolve and what shapes their properties. This course describes the observational facts of galaxies and the various processes of galaxy evolution as seen from theoretical/numerical models. |
| **ENG-466**<br>**Distributed intelligent systems**<br>**(5 ECTS)**<br><br>**Professor: Martinoli Alcherio** | The goal of this course is to provide methods and tools for modeling distributed intelligent systems as well as designing and optimizing coordination strategies. The course is a well-balanced mixture of theory and practical activities. |
| **ME-523**<br>**Nonlinear control systems**<br>**(3 ECTS)**<br><br>**Professor: Müllhaupt Philippe** | Non-linear systems are analysed with a view to establishing control laws. Stability in the Lyapunov sense is presented, as well as geometric control methods (exact linearisation). Various examples illustrate the theory (paper and pencil exercises and computer simulations). |
| **ME-422**<br>**Multivariable control**<br>**(4 ECTS)**<br><br>**Professor: Ferrari Trecate Giancarlo** | This course covers methods for the analysis and control of systems with multiple inputs and outputs, which are ubiquitous in modern technology and industry. Special emphasis will be placed on discrete-time systems due to their relevance to digital and embedded control architectures. |
| **MICRO-580**<br>**Robotics project I**<br>**(10 ECTS)**<br><br>**Supervisor:**<br>**Kneib Jean-Paul Richar** | The student applies the acquired skills in an engineering or a research project.<br><br>Performed at EPFL/LASTRO/Astrobots on the fine open-loop control of a folding mirror for ESO VLT's BlueMUSE integral field unit. |